EVALUATING OPTIONS TO UTILIZE EXTENSIVELY MANAGED PASTURES

PhD THESIS

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Head of School: **Dr. László Heszky**
Univ. Prof, Regular Member of the Hungarian Academy of Sciences
Faculty of Agricultural and Environmental Sciences, Szent István University
Gödöllő

Supervisor: **Dr. László Szemán**
Associate Professor, PhD in Agricultural Sciences
Institute of Crop Production, Faculty of Agricultural and Environmental Sciences, Szent István University Gödöllő

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Dr. László Heszky
Head of School

Dr. László Szemán
Supervisor

1. BACKGROUND

More than half of the area of the European continent and more than two thirds of the area of Hungary are used for cultivation (ÁNGYÁN et al., 2003). Obviously, the ratio of land use forms as well as their national significance vary within cultivated areas. The area under pasture management has decreased by 400 000 hectares in the past 20 years in Hungary (resulting in a total pasture area of 762.6 thousand hectares, not including pastures used for meliorative purposes) (Hungarian Central Statistical Office, 2010). According to data from the 1990s, (HORN és STEFLER), 60% of the Hungarian pasture area was extensively managed in those years. According to TASI (2011), the total area of dry pastures, suitable for extensive management is 487 000 hectares in Hungary. Referring to the 2010 report of the Hungarian central Statistical Office, this area corresponds to 64% of the total area registered under pasture management (762 000 hectares). These data prove that extensive methods, as part of the Hungarian pasture management system, need to be addressed in detail. One objective of extensive pasture management is to design and implement a pasture utilisation regime to be used by animal husbandry, based on the natural production capacity of the pasture (while at the same time facilitating plant-soil interactions and supplying animals' fodder demands). The other objective is to preserve species diversity characterising the natural habitat of the plant association by designing and implementing sustainable management technologies. Obviously, the most important criteria of extensive management do not only include low nutrient input but also the preservation or even enhancement of biodiversity.

OBJECTIVES

My main research objective was to suggest optimal utilisation systems for the most frequent extensively managed pasture types in Hungary (wet and dry pastures), complying with the following criteria:

- should be dependable as a forage source, with predictable yields of appropriate quality.
- do not impair the pasture's natural values but in fact, potentially contributes to maintaining or creating semi-natural conditions.
- extend the grazing season as much as possible regardless of whether the pasture is used exclusively or only seasonally for grazing.

The following studies served as foundation for the research:

- A study of the link between frequency of use and length of the regenerative period (2006-2009):
  - in dry natural pastures,
  - in originally sown wet pastures
- A study of extending pasture utilization over late autumn and into the winter and an assessment of the quantity and quality of harvested forage over same period (1999-2002)

2. MATERIALS AND METHODS

To implement research objectives, the following methods were applied:

- To define a dependable, predictable yield of appropriate quality for livestock feeding
  - using the so-called 'conventional' method, the wet and dry pastures in question were assessed for their dry matter, crude protein and crude fibre content as well as for the digestibility and net lactational energy of their yield
  - species composition, cover abundance and height of the various species in the wet and dry pastures were determined using quadrat sampling (Balázs-method); the data were then used to calculate a 'K-value' representing pasture quality, and a 'P-value' representing pasture productivity
  - finally, the strength of the correlation between the results obtained through the two methods was assessed

- To assess options for an extended grazing season:
    - dry matter content of the yield was determined,
    - its crude protein and crude fibre content, its digestibility and net lactational energy were determined,
    - its ergosterol content, an indicator of fungal infection levels, was also determined

When studying the link between frequency of use and length of the regenerative period, I simulated the following pasture management methods:

Method of use	**Frequency of use/year**
1. Pasture management for nature conservation	2x
2. Meadow management (cutting first growth, grazing new growth)	3x
3. Strip grazing	4x

It is important to note that in the case of meadow management and strip grazing, grazing was actually simulated by cutting for reasons of feasibility.

A short summary of the experiments completed in the course of my research is presented in *Tables 1 and 2*.

Table 1: Link between frequency of use and length of the regenerative period

Treatment	**Level**	**Date**
Frequency of use	2x/year	30 June 10 October
	3x/year	18 May 30 June 10 October
	4x/year	18 May 30 June 5 August 10 October
Years	2006 2007 2008 2009	
Location	Dry natural pasture (Bösztör, Hungary) Wet sown pasture (Mende, Hungary)	

Table 2: Assessing options for an extended grazing season

Treatment	Level
Summer use	June
	July
	August
Winter cutting	November
	December
	January
Years	2000/2001
	2001/2002
	2002/2003

The link between frequency of use and length of the regenerative period was examined on a dry pasture, the largest in Hungary (Bösztör) and a wet pasture most suitable for forage production (Mende). Both pastures are under extensive and ecological management.

Site 1 (Bösztör)

The whole areas of the dry pasture at Bösztör belongs to the Kiskunság National Park. Within Hungary, Bösztör is located in the small region Solti-sík that belongs to the medium region Dunamenti-síkság within the region of the Alföld (Great Plain). The site itself is located near Kunszentmiklós. Its location, according to GOOGLE EARTH (2009): Northern Latitude 46°56' 41''; Eastern Longitude 19° 06' 44"; elevation: 95 m above sea level. The small region including the site has a temperate, dry climate. The annual number of sunshine hours is 2000. The number of sunshine hours in the summer is about 780; 180 in the winter. Annual mean temperature is 10.3-10.5 °C. The absolute maximum temperature is 34.0 °C and absolute minimum temperature is -16.0 – 17.0 °C, calculated as averages of several years.

Site 2 (Mende)

The wet pasture at Mende is located in a valley with heavy dew formation. Mende is located in the small region Gödöllői-dombság that belongs to the medium region Cserhát vidék within the hilly region of Észak Magyarországi Középhegység. Its location, according to GOOGLE EARTH (2009): Northern Latitude 47°25' 54''; Eastern Longitude 19° 29' 13"; elevation: 175 m above sea level. The small region including the site has a temperate, dry climate. The annual number of sunshine hours is about 1950. The number of sunshine hours in the summer quarter is about 780-790; 190 in the winter. Annual mean temperature is 9.7-10.0 °C. Mean temperature in the growing season is 16.5-17.0 °C. The absolute maximum temperature in the summer is 32.5-33.0 °C and absolute minimum temperature in the winter is -16.0 °C, calculated as averages of several years.

Gödöllő

The options for an extended grazing season late in the autumn and in winter were examined at a sown pasture (**Gödöllő**) where the dominant species was *Festuca arundinacea*. Experimental plots were located in the Crop Production Educational Farm of Szent István University (Northern Latitude 47°34' 33''; Eastern Longitude 19° 22' 45"; elevation: 230 m above sea level) (GOOGLE EARTH 2009). Gödöllő is located in the small region Gödöllői-dombság that belongs to the medium region Cserhát vidék within the hilly region of Észak Magyarországi Középhegység. The

small region is characterised by a temperate dry climate in the area of Gödöllő. The annual number of sunshine hours is about 1950. The number of sunshine hours in the summer quarter is about 780-790; 190 in the winter. Annual mean temperature is 9.7-10.0 ^{o}C. Mean temperature in the growing season is 16.5-17.0 ^{o}C. The absolute maximum temperature in the summer is 32.5-33.0 ^{o}C and absolute minimum temperature in the winter is -16.0 ^{o}C, calculated as averages of several years.

The following tests and calculations were performed to assess the quality of forage.

	Unit of measurement	**Method**
Crude protein	g * kg^{-1} d.m.	VDLUFA, 1983 – Vorschrift 4.1.1
Crude fibre	g * kg^{-1} d.m.	VDLUFA, 1983 – Vorschrift 6.1.2
Crude fat	g * kg^{-1} d.m.	VDLUFA, 1983 – Vorschrift 5.1.1
N-free material	g * kg^{-1} d.m.	1000 – crude protein – crude fibre – crude fat – crude ash (g)
Organic material	g * kg^{-1} d.m.	1000-crude ash (g)
Digestibility	%	TILLEY & TERRY (1963) *in vitro* method and PÓTI & BEDŐ, 1993; CZAKÓ, 1982)
Digestible energy	MJ * kg^{-1} d.m.	DE = (digestible protein +2.25 digestible fat + digestible fibre + digestible Nmka) * 0.01845 (SCHMIDT et al., 2000)
Metabolised energy	MJ * kg^{-1} d.m.	ME = 0,82 DE (SCHMIDT et al., 2000)
Net energy (for maintenance of life processes)	MJ * kg^{-1} d.m.	Ne_m= 1,37 ME – 0,03298 ME^2 + 0,0005998 ME^3 – 4,6861 (SCHMIDT et al., 2000)

The concentration of ergosterol was determined from a petrol ether extract by high performance liquid chromatography (HPLC) (SCHWADORF & MÜLLER, 1989).

Plant stands were sampled by the quadrat method of Balázs. Pastures were evaluated using the estimation method of Ferenc Balázs (1960).

Coenology was assessed by means of the social behaviour types defined by Borhidi (1993). Social behaviour types (SBT) indicate the naturalness of the plant community, expressing the level of naturalness and disturbance of the relationship between the species and their habitat, also quantifying naturalness.

Statistical analysis was done in EXCEL. Data were analysed by one-way ANOVA and linear regression (SVÁB, 1981). Results were evaluated according to SVÁB (1981): 'Biometriai módszerek a kutatásban' (Methods of Biometry in Research).

3. RESULTS

3.1 Changes in species composition

Site 1

The plant community of the Bösztör dry pasture is *Achilleo - Festucetum pseudovinae* (salt pasture) that is characteristic for dry, slightly degraded saline steppes and meadows. The species are disturbance-tolerant, indicating slight degradation in places. The number of species in the dry pasture with a saline undersoil was 35-45. The cover abundance of useful grasses exceeded 50% in

all cases. The dominant species of the pasture was *Festuca pseudovina*, a species of secondary importance for animal nutrition.

According to my results, neither too infrequent nor too frequent use is recommended regarding vegetation coverage as the rate of bare areas is significantly larger at frequencies of 2x/year and 4x/year than in the case of 3x/year. The group ”other dicotyledons” benefitted most from the 2x annual use regime. For this group, the highest number of species and coverage were measured in the case of 2x annual use. I have to note however, that poisonous plants and species with prickles showed a significant increase (10%) at the 2x/year frequency. These changes were probably caused by intense precipitation and underuse as the rate of these unfavourable species was only 5% at the 3x/year frequency of and 4.5% in the case of 4x/year.

Site 2

In the wet pasture, the number of species was low (9-10 species). The coverage of grasses exceeded 50% in all cases, the dominant species was *Festuca arundinacea*. My research proved that the area had been originally underused as the site was cut once a year only, very late in the season. An increased frequency of use improved species composition (regarding usefulness for animal nutrition) already at a 2x/year frequency.

3.2 Naturalness index

Site 1

In Bösztör, species composition and abundance showed significant seasonal changes. These changes were mainly weather-related. While 2006 had average weather conditions, 2007 was dry and 2008 was rather wet. In 2009, precipitation was low again. Species composition and changes in cover abundance followed the variances in weather. When quantifying the naturalness of pastures, values were high (around 400, almost twice as high as for Site 2) in 2006. The dry weather favoured *Cynodon dactylon* reduced the value of all the indexes in 2007, however, values increased again significantly in 2008. In 2009, at a low frequency of use (2x/year), a significant fall of index values was observed again. In the last study year, frequent use (4x/year) also reduced values. In 2009, the frequency of use that resulted in an increase in naturalness values was 3x/year.

My results showed that the dry pasture at Bösztör was more natural than the wet pasture at Mende, being more valuable as a natural site than the latter one, however, it showed a more sensitive response to changes in the weather than sown wet pasture at Site 2. Use of frequency had a great impact on species composition. According to my results, pasture management that complies with the requirements of nature conservation (2x/year frequency of use) results in a more sensitive response to changes in the weather, regarding species composition whereas the problem is not as distinct in the case of meadow management (3x/year frequency of use).

Site 2

In the case of the wet pasture at Mende one cannot talk about ”naturalness” as the pasture was sown for forage production. Thus, the number of species to be investigated was quite low (9-10 species mostly). Plants recorded during sampling usually belonged to on of 4 to 5 categories, which went as low as 3 in the last year. The site is characterised by disturbance tolerant (DT) species. The calculated Borhidi index values, falling into the range of 216-229, do not indicate even a semi-natural condition. No significant changes in index values were observed during the survey; a minor decrease was recorded at 2x/year and 4x/year frequencies of use. By a frequency of 3x/year, however, an increase could be observed in 2009. Seasonal variation in weather did not result in significant changes, species composition was uniform regarding naturalness indexes, the total Borhidi scores showed no seasonal variations. At a 2x/year frequency,, naturalness decreased. Disease tolerant species occupied larger areas year by year, replacing natural competitors and generalists. Such negative tendencies could not be observed at the 3x/year and 4x/year frequencies.

3.3 Determining a pasture management system that complies with the pasture's ecological demands using traditional methods

In Hungary, the pastures types most widely found are wet and dry pastures. The aim of my research was to determine a pasture management system that complies with the ecological features of the given pasture. Using the traditional method, the dry matter yield of pastures was determined by test cuts whereas the quality of the forage was analysed in the laboratory. The quality of forage was determined by its crude protein content, digestibility and net energy to maintain life processes.

3.3.1 Dry matter

Site 1

At site 1, gross dry matter yields as per hectare varied between 0.98 and 3.18 tons in 2007 and 2008, respectively. The pasture dominated by a species of secondary importance, *Festuca pseudovina*, was not influenced by the frequency of use, as no statistical correlation could be established between yield and frequencies (2x/year, 3x/year or 4x/year). Dry matter yield only varied significantly with the season at Site 1. Drought had the strongest negative effect on yield in the case of the management regime complying with the requirements of nature conservation (2x/year frequency of use).

Site 2

The dry matter yield at Site 2 is statistically different from that of the dry pasture at Site 2. The wet pasture yielded 3-4 times as much as the dry one.

Drought had the strongest negative effect on yield in the case of the management regime complying with the requirements of nature conservation (at a 2x/year frequency of use). Frequent use (4x/year) resulted in the highest increase in year in the wet season of 2008.

3.3.2 Crude protein

Site 1

The crude protein content of the dry matter yield varied between 74.2-118.4 g/kg. The crude protein content of the forage did not reach 12% in either year, so it cannot be classified as excellent for grazing. Frequency of use had a significant effect. The 2x/year frequency of use resulted in significantly lower crude protein contents in each year, mainly caused by performing the first cut late in the season. With meadow management (3 uses a year), the crude protein content of the forage was mainly influenced by the length of the regenerative period.

Site 2

The crude protein content of the dry matter yield of the wet pasture varied between 69.9 g/kg (in 2007, by a frequency of use of 2x/year) and 135.9 g/kg (in 2008, by a frequency of use of 4x/year). Crude protein content values of the harvested forage indicate medium quality as they reach the amount of 120 g/kg (dry matter) only in 4 cases. The 2x/year frequency of use of resulted in significantly lower crude protein contents every year than with higher frequencies while in the case of higher frequencies of use (3x/year and 4x/year), differences were not significant.

3.3.3 Relationship between the frequency of use and digestibility of organic material

Site 1

The results indicate relatively low digestibility, with values varying between 44.9-55.2%. Digestibility was the lowest in 2006 at a 2x/year frequency of use of and the highest in 2008 at a 4x/year frequency. No significant relationship could be established between frequency of use and digestibility. Although the difference between the digestibility of organic material from low frequency of use (2x/year) and that from the higher frequencies was almost 10%, this difference was not statistically representative as the variation between replicates was too large.

Site 2

At the wet sown pasture at site two, digestibility varied between 57.5% and 75.7%. Compared to the dry pasture at Bösztör, the digestibility of harvested forage was much better. Also at this site, the lowest digestibility was measured in 2007 at a frequency of use of 2x/year and the highest in 2009, at a frequency of 4x/year. A significant relationship between frequency of use and digestibility could be established in both 2006 and 2009; in both years, the digestibility of the forage from the plots used twice a year was significantly worse than that from a frequency of use of 4x/year.

3.3.4. Relationship between the frequency of use and net energy (for maintenance of life processes)

Site 1

Energy yields were low in each year, varying between 3957-15681 MJ/ha. The lowest value was measured in 2007, at a frequency of use of 2x/year and the highest in 2008 at a frequency of 4x/year. No significant relationship could be established between frequency of use and net energy content in either year.

Site 2

In the 4 study years, significantly higher net energy yields were measured for Site 2 compared to the dry pasture at Site 1, values varying between 24900-82746 MJ NE_m/ha. The lowest value was measured in 2007, at a frequency of use of 2x/year and the highest in 2008 at a frequency of 4x/year. From year 3, NE_m was significantly lower in the case of lower frequencies of use (nature conservation) than in the other cases (3x/year and 4x/year). Regarding animal nutrition, less frequent use was disadvantageous.

3.4 Evaluating pasture management methods using the Balázs method

In themselves, neither quantity or quality characteristics enable us to define or compare the actual value of pastures. This is why Ferenc Balázs created the term productivity (P-value) that combines quality and quantity characteristics of the yield, independent of the site ($P=\sum kt/100$). To determine the productivity of a pasture, the plant community should be sampled and the Balázs calculation performed as many times as the pasture is used. Their sum provides sufficient insight into the actual productivity of the pasture.

Site 1

The sum of the annual P-values according to intensity of use was the lowest (1.5) in 2007 at a frequency of use of 2x/year and the highest in 2008 (4.0), at a frequency of 4x/year. Frequency of use had a significant effect on P-value in several cases. The P-value for 2x/year frequencies was significantly lower than that for the 4x/year frequency each year. The difference was also statistically significant when comparing the frequencies of 2x/year and 3x/year in 2006 and 2007. Comparing the frequencies of 3x/year and 4x/year, the difference was statistically different only in 2008, the former frequency of use resulting in a lower P-value than the latter.

Site 2

The P-values calculated for Site 2 exceeded those for Site 1 four-five times. The sum of the annual P values according to intensity of use was the lowest (7.8) in 2007 by a frequency of use of 2x/year and the highest in 2008 (16.4), at a frequency of 4x/year. The P-value for 2x/year frequencies was significantly lower than that for the 4x/year frequency in 2006 and 2007. Comparing the frequencies of 3x/year and 4x/year, the difference was statistically different only in 2008, the former frequency of use resulting in a lower P-value than the latter.

3.5 Comparison of the traditional and the Balázs method

To be able to compare the results described in sections 3.3 and 3.4, a correlation analysis was performed. As it was important that the data yielded by the two different methods include both forage quality and quantity parameters, the NE_m yield (traditional method) was compared to the productivity value (Balázs method).

Site 1

The correlation coefficient between the indexes yielded by the two methods was r=0.8 ($P<0.05$), i.e. the correlation was significant (SVÁB, 1981). When the correlation was tested on a year by year basis, it was highly significant in 3 years out of 4 and only intermediate in one year (2007).

Site 2

The correlation coefficient between the indexes yielded by the two methods was r=0.8 ($P<0.05$), i.e. the correlation was significant (SVÁB, 1981). When the correlation was tested on a year by year basis, it was highly significant in 1 year out of 4 (2008), significant in 2 years (2007 and 2009) and intermediate in one year (2006). These correlations highlight the potential benefits of using the estimation-based Balázs method as it is much more cost- and time-effective than the traditional pasture evaluation method.

3.6. Extension of the grazing season

3.6.1. Plant community trends

The ageing sown pasture was characterised by a relatively closed plant community at the beginning of the experiment. Total coverage of the plots varied between 84-95%. The rate of grasses decreased radically (by 15-20%), they were replaced by bare patches and about 5% of the area formerly covered by them was occupied by other dicotyledonous pasture species. These changes indicate improper pasture management and lead to degradation and weed problems on the long run. I have to note. however, that the surveyed site was a pasture sown more than 10 years ago. The large bare area was not only the result of winter use, however, this management regime accelerated the natural extinction of sown grasses and the transformation of the plant community. In this particular case, winter use had an adverse effect on species composition and cover abundance.

3.6.2 Dry material

Dry material yields were significantly different in the 3 survey years. In the second year, forage dry material yield from November was twice as much as those coming from any other cut, regardless of the date of the last summer cut.

3.6.3 Crude protein

Differences between winter uses were significant only in the second year, in the November-December and the November-January comparisons.

3.6.4 Crude fibre

In Gödöllő, the crude fibre content of forage from winter uses, 242-313 g/kg, was rather similar to that of the Mende and Bösztör pastures, measured in the vegetative period. In the first and third year, crude fibre contents measured in January were significantly higher than those measured in November or December, regardless of the date of the summer use. In these years, crude fibre contents showed a gradual increase, caused by the aging of the plant stand. In the second year, the crude fibre content measured in November were significantly lower than those of the forage batches harvested later. The sudden peaks of crude fibre content in December were caused by the permanent (31-day long) snow cover and cold weather, as both promote the withering of above-ground plant parts and the increase of fibre fractions.

3.6.5 Net energy (for maintenance of life processes)

Net energy values varied between 1888-16153 MJ NE_m/ha. The lowest energy yields were measured for the January cut in the third year, the highest for the new growth cut in November in the second year. When interpreting the results, it should be noted that only the forage harvested after the vegetative period was analysed. Considering this, results indicate that the forage harvested late in the autumn and in winter from the Gödöllő pasture yielded almost as much net energy (and sometimes even more) as that from the dry pasture in the whole vegetative period. The date of winter use had a significant effect on NE_m yields, values from November were significantly higher than those from December and January each year.

3.6.6. Ergosterol

Ergosterol contents, which indicate fungal infections, from late autumn and winter uses that facilitate an extended grazing season were lowest (27 mg/kg dry matter) in November in the second year and highest (234 mg/kg dry matter) in January in the first year. The difference between these two values is almost tenfold. The forage harvested in November contained significantly lower concentrations of ergosterol than that from the latest (January) use each year. In the first and the second year, concentrations in November were also below those from December and the differences were significant. In the third year, the forage harvested in December was less infected by fungal diseases than that from January, the difference being significant again. According to WOLF (2002), ergosterol concentrations are higher in older pastures, i.e. when the summer cut is scheduled earlier. However, ergosterol concentrations in the youngest growth (when the summer cut was performed in August) were unusually high in November in the first year and in December of the second year, after months of intense precipitation. These results indicate that fungi infest young plant stands faster and to a higher extent when promoted by intense precipitation or permanent snow cover than they do older stands.

4. NEW SCIENTIFIC RESULTS

1. In dry pastures, pasture management that complies with nature conservation requirements increased the ratio of bare areas year by year. The Borhidi naturalness index showed unfavourable changes, too. As a result of this type of pasture management (a frequency of use of 2x/year combined with a first cut late in the season), the responses shown by the plant community to seasonal variations were more sensitive than those measured in the pasture under meadow management (a frequency of 3x/year).

2. In the wet pasture, mismanaged for years (by underuse), regular use resulted in a significant increase in net energy yields (except for the very dry season), without fertilising or other extra agro-technical input. According to the traditional pasture evaluation method of, meadow management (a 3x/year frequency of use) had a beneficial effect regarding animal nutrition parameters in dry and extremely dry years whereas in wet seasons strip grazing (a frequency of 4x/year) showed the best results. The pasture evaluation method based on estimations indicated that strip grazing had the most beneficial impacts on animal nutrition parameters, regardless of the season.

3. Net energy yields as per hectare, calculated by the traditional method (test cut, laboratory analysis), and productivity values calculated by the estimation-based Balázs method strongly correlated (r=0.8); this correlation was independent of site.

4. My results did not support previous findings, i.e. I found the nutritional value of the extensively managed pasture dominated by *Festuca pseudovina* to be very low; results from four years showed that net energy (for the maintenance of life processes) varied between 3.2 and 4.8 MJ/kg dry matter whereas digestibility fell into the range of 45-55%. These values were calculated by the TILLEY-TERRY method (1963), by the *in vitro* analysis of rumen liquid.

5. In the pasture dominated by *Festuca arundinacea*, the grazing season may be extended until the end of December under average Hungarian conditions, without a significant deterioration of forage quality.

5. CONCLUSION AND RECOMMENDATIONS

Changes in the plant community

In the dry pasture (Bösztör), results from pasture management complying with the requirements of nature conservation and a management regime simulating strip grazing **indicated regular underuse and overuse**. **Such pasture management regimes result in the formation of bare patches** potentially promoting the invasion of weed species. According to my results, pasture management complying with the requirements of nature conservation (frequency of use of 2x/year) in the dry pasture resulted in underuse in the wet season of 2008. However, as the Bösztör pasture is located in a dry area, the extremely wet season of 2008 cannot be considered as a benchmark. The values of the Borhidi naturalness index also prove that the pasture under a **pasture management that complies with the nature conservation requirements (a 2x/year frequency of use**) is **highly sensitive** to seasonal variations in the weather, which results in significant seasonal variations in other parameters. Increased frequency of use (4x/year) did not improve the values of the naturalness index either. Meadow management was the only method that yielded beneficial changes regarding the naturalness of the pasture. The site is located in the Kiskunság National Park, hence the pasture management that complies with the nature conservation requirements (a 2x/year frequency of use, with a first cut late in the season). My results on the changes in the plant community obviously indicate that **this is not the best way to manage** this dry pasture (Bösztör). a 3x/year frequency of

use, corresponding to the **meadow management** regime is a **better option** under these particular conditions.

In the wet pasture (Mende) a frequency of use as low as 2x/year already resulted in favourable changes in the plant community; plant composition improving compared to results from the neighbouring areas, regarding animal nutrition parameters. **The plant community showed no significant adverse responses to any frequency of use.**

Dry matter

Results from the traditional method of pasture evaluation indicate that the extensively used natural dry pasture **did not respond to the various frequencies of use**. This is hardly surprising, considering that the pasture is dominated by *Festuca pseudovina*, a species of secondary importance for animal nutrition. Such grass species yield low quantities, they do not show strong responses to fertilising and, as indicated by my results, neither to variations in the frequency of use.

Regarding quantity, the originally sown wet pasture responded with the **most level yields** to **meadow management** (at a 3x/year frequency if use). As the pasture is located in an area with excellent water supply**, strip grazing** (a 4x/year frequency) **is also a feasible option if the weather is not extremely dry**.

Comparing the two different pastures, it is obvious that in the extremely dry year yields decreased more drastically in the dry pasture than in the wet pasture. In the wet season, the Mende wet pasture of yielded higher quantities. In the case of strip grazing (frequency of 4x/year), the dry matter content of the yield increased by 85%, whereas the same treatment resulted in a 28% increase only, in the dry pasture of Bösztör.

Crude protein

In the dry pasture, pasture management complying with the requirements of nature conservation (a 2x/year)frequency of use) did not result in significant differences between the crude protein contents of the first and the second growth. **The first cut performed late in the season did not have a significant adverse effect on quality in the pasture dominated by short fescues**. In the case of meadow management (a 3x/year frequency of use), the length of the regenerative period was the main factor influencing the crude protein content of the forage. **We may conclude that the length of the regenerative period and seasonal variance were the main factors determining the crude protein content of the forage.**

In the wet pasture, pasture management complying with the requirements of nature conservation resulted in significantly lower crude protein concentrations each year, compared to the more intensive methods of use. **Low frequency of use resulted in significant deterioration in forage quality in this sown pasture with an ecologically favourable location.**

Comparing the two sites, the crude protein concentrations resulting from pasture management complying with the requirements of nature conservation did not differ significantly. Meadow management and simulated strip grazing resulted in higher crude protein concentrations in the wet pasture compared top the dry one. **Frequency of use had no significant effect on crude protein concentration in the dry pasture whereas increased frequency of use had a beneficial impact on crude protein contents in the wet pasture.**

Digestibility and net energy (for the maintenance of life processes) (NE_m)

The digestibility and net energy content of forage was **primarily determined by the season** in the dry pasture (Bösztör). Previous research (BEDŐ, 1986; SCHMIDT et al., 2000) showed that the dominant species of Hungarian indigenous pastures, ***Festuca pseudovina,*** provides low yields but good nutritional quality (NE_m: 5,2-5,66 MJ/kg dry matter). My research did not verify these results, **forage quality was low in each of the four survey years** (NE_m: 3,2-4,8 MJ/kg dry matter).

The wet pasture **showed a less expressed response to seasonal variation while responding significantly to the frequency of use.** Digestibility and NE_m were the lowest under pasture

management complying with the requirements of nature conservation (frequency of use of 2x/year) and **the highest** in **strip grazing** (frequency of use of 4x/year). It proves that the **best option for use** in wet pastures is **strip grazing that utilises four growths a year**, according to the results of net energy and digestibility, both indicating forage quality.

Net energy (for maintenance of life energy)

In the dry pasture, the net energy yield as per hectare did not show a significant correlation with the frequency of use. Seasonal variation had the only significant effect.

From the third year **in the dry pasture,** NE_m was significantly lower in the case of management complying with the requirements of nature conservation than in treatments with more frequent use (3x/year or 4x/year). According to the results, **meadow management appears to be a favourable option on dry and extremely dry years whereas in wet years, strip grazing provides the best yields** for animal nutrition.

Summarised results of the Balázs evaluation method

The method that evaluates pastures on the basis of estimations indicated medium quality for the extensively managed dry pasture (Bösztör). Productivity was lower in the case of management complying with the requirements of nature conservation than in treatments with more frequent use each year. Forage quality was good in the wet pasture at Mende. Just as in the case of the dry pasture, a frequency of use of 4x/year gave the best productivity results, independent of seasonal variations.

Comparison of the traditional and the Balázs method

One complex area-unit based parameter, including both forage quality and quantity, from the two different pasture evaluation methods each was used for comparison. Net energy (for the maintenance of life processes) as per hectare from the traditional method was compared to productivity (P-value) from the estimation based method. The correlation was significant (r=0.8). As the price of performing the two methods differ substantially (the traditional laboratory method is cost and time intensive) and the correlation between the results given by the two methods was string regardless of the difference between the sites, more comparative studies are recommended in this field. The biggest problem I had with the **Balázs method** during my research work was **its disregard for the phenological state of the plants when determining the quality of components of the pasture** as the author presumes an optimal scheduling for utilisation. However, in the case of management complying with the requirements of nature conservation, the first cut is scheduled rather late in the season, thus the nutritional value of the plants is actually much lower than the values given by the Balázs method.

Extension of the growing season

The quantity and quality of forage harvested in November was sufficient in all the 3 survey years. In the second year, I measured extremely high values for net energy (for maintaining life processes) as per hectare (more than 16000 MJ NE_m/ha) in the growth harvested in November. December values were lower but, still in 5000-6000 MJ NE_m/ha, represented a high enough energy content to justify the extension of the grazing period. Fungal infestation of the forage was primarily weather-dependent. In wet, mild seasons, the spreading of fungi was most promoted in young plant stands by a permanent snow cover. One of the controversial issues of winter use is grazing on a wet, soft surface. Even though grazing was only simulated in my research and animals were not actually present on the fields, the density of stands was observed to be decreasing. However, it was the cover abundance of grasses that decreased substantially and this might have been caused by ageing, too. Summarising the results we may conclude that in pastures dominated by plant species tolerating treading and winter grazing (e.g. *Festuca arundinacea*) and by favourable weather (where the soil is tough enough) the **grazing season should indeed be extended till November** but December may also yield good results, weather allowing.

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